

Writing a Scientific Research Paper

Writing Resources

Besides the information noted in your course materials and this handout, other writing resources are available:

- *The Mayfield Handbook of Technical and Scientific Writing* and other on-line resources are available at <<http://web.mit.edu/uaa/www/writinglinks>>.
- The Writing and Communication Center <<http://web.mit.edu/writing>> is located in 14N-317, x3-3090.
- IEEE website: <http://standards.ieee.org/guides/style/index.html>

Standard Scientific Research Paper Components

Scientific papers generally follow a conventional format that includes a title, an abstract, a reference (or Literature Cited) section and the components of the IMRAD structure:

The IMRAD structure

I ntrouction	answers “why?”
M ethods	answers “when, where, how, how much?”
R esults	answers “what?”
And	
D iscussion	answers “so what?”

Writing Process

Sample Writing Process

Prewriting	<ul style="list-style-type: none"> • Make notes, scribble ideas: start generating text, drawing figures, sketching out presentation ideas. • Ignore neatness, spelling, and sentence structure--get the ideas down. • Analyze audience and purpose to focus your writing.
Writing	<ul style="list-style-type: none"> • Start with whatever section is easiest to write. • Skip around to different sections as needed. • Keep writing.
Revision	<ul style="list-style-type: none"> • Work on content first, then structure, then style. • Keep focused on your main purpose: communicating, reasoning, presenting clearly. • Get feedback. • Circle back to prewriting as needed.
Editing	<ul style="list-style-type: none"> • Check all data for accuracy. • Review for grammatical, mechanical, and usage errors.
Proofread	<ul style="list-style-type: none"> • Print and read your report again. Often we don't see errors on-line as easily as we do on a hard copy.

Elements of the Scientific Research Paper

- Title
- Abstract
- Introduction
- Methods
- Results
- Discussion
- Works Cited
- Appendices

While all scientific research reports share a common organizational setup, you will find variations within reports. The common structure of the report is to ensure ease of reading. Researchers must quickly filter the huge amount of information available in scientific publications. A common organizational structure helps readers move quickly through reports. In fact, often scientists do not read entire reports and rarely read them in chronological order. For example, they may skip directly to the findings and not read the methods. The discrete sections of a report also force the researcher to carefully distinguish the various aspects of the experiment. For example, what is a result and what is your interpretation of that finding?

Title

- informative and specific
- concise
- understandable

See example

Too vague: "Measuring a nerve response in a Frog"

Just right: "The Effects of Ethanol on the Compound Action Potential of a Frog Sciatic Nerve"

Notice:

- The title is on a Cover Page
- The title is descriptive and concise (no jargon). It tells the reader what effect you measured and on what organism
- All nouns are capitalized in the title
- The title is centered on the page
- Your names and date appear below the title

Abstract

The abstract is a one paragraph (<100 words) summary of the report, including the question investigated, the methods used, the principal results and conclusions.

- offers a complete but selective summary of most significant ideas and information
- uses clear, precise wording (increase precision through successive revisions)
- accurately reflects the paper's organization, emphasis, and content on a very small scale

Why do we write abstracts? Abstracts are a quick way for readers to understand your research project. Thus, readers can assess the relevance of your work to their own simply by reading your abstract. Your intended audience should be able to understand the abstract without having to read any of the report. Because the abstract is usually the first thing that readers read, and based on that abstract, make a judgment whether to keep reading or not, the abstract is one of the most important elements of a scientific report.

See example

Notice:

- The abstract summarizes your research in one paragraph.
- The abstract includes results
- The language is concise and easy-to-read.

Introduction

The introduction is a brief section (no more than 1 page usually) designed to inform the reader of the relevance of your research and includes a short history or relevant background that leads to a statement of the problem that is being addressed. Introductions usually follow a *funnel* style, starting broadly and then narrowing. They funnel from something known, to something unknown, to the question the paper is asking.

- focuses on the overall issue, problem, or question that your research addresses. What is the context of your study (i.e. how does this relate to other research)?
- provides *sufficient* context and background for the reader to understand and evaluate your research, including appropriate visual aids (drawings, etc.). Warning: Don't be too long-winded here. You do not need an entire history of frog biology, for example.
- defines terms which your reader may not know. Remember other students are your audience.
- defines abbreviations that will be used in the report. For example, "The compound action potential (CAP) . . ." In following instances, you may use "CAP" in place of compound action potential.
- develops the rationale for your work: poses questions or research problems and outlines your main research focus. What was your research question?

See example

Methods

The Methods section chronologically describes the process you undertook to complete the research. The method is written as a process description, not as a lab manual procedure. Be precise, complete, and concise: include only relevant information—no unnecessary details, anecdotes, excuses, or confessions.

- details experimental procedures
- describes techniques for tracking functional variables (timing, temperature, humidity, etc.) and rationale for tracking those variables
- explains analytical techniques used

See example

Notice:

- You do NOT need to repeat the frog dissection process described in the lab manual. You only need to describe your specific experiment method.
- You do not need to include an equipment list.
- The methods section is written in paragraph form. It is NOT written like a cookbook or a series of steps.
- It includes reasons why the team took certain measurements or chose to use certain equations.
- It does NOT tell us what was discovered. That information should be in the Results section.
- It's broken down into subsections, if appropriate.
- It includes visuals that are labeled and referenced in the text. Tables and graphs are numbered consecutively in the report (Table 1, Table 2, etc.). Tables and graphs include a title.
- Visuals are large enough to read the units. Each visual does not extend across more than one page.
- Decimal quantities include a 0 before the decimal point. For example, 0.05.
- Notice the format of mathematical expressions. Equations are spaced apart from the text.

Results

What are results? "Just the facts, mam."

The Results section DESCRIBES but DOES NOT INTERPRET the major findings of your experiment. Present the data using graphs and tables to reveal any trends that you found. Describe these trends to the reader. The presentation of data may be either chronological, to correspond with the Methods, or in the order of most to least importance. If you make good use of your tables and graphs, the results can be presented briefly in several paragraphs.

A note about visuals: Often you'll find it more compelling to include two sets of results within one graph. For example, if you are comparing the distance in time between peaks for various concentrations of alcohol, include these findings in ONE graph. It's easier for

the reader to see the comparison if visually the data are together rather than across graphs.

- Organize logically and use headers to emphasize the ordered sections.
- Report; don't discuss or interpret. Findings are matters of fact; interpretation fluctuates with perspective, opinion, and current knowledge. Reasoned speculation belongs in Discussion; important facts and objective observations that are unambiguously true belong in Results.
- Illustrate and summarize findings: organize data and emphasize trends and patterns with appropriate visuals.
- Integrate visuals with text: the text offers claims and general statements that the visual details support.

See example

Notice:

- There is text! The authors explain what is shown in each graph as well as interesting anomalies. Visuals don't fully explain, so don't expect your readers to "get" what you mean by providing a graph with no explanation.
- All figures are labeled and referenced in the text prior to the figure.
- There is no interpretation.
- The authors have added subsections to organize the data.
- Negative results are results and worth including in your report.
- Notice that the authors have probably not included all of their findings. While the Results section is supposed to objectively describe your research results, it is actually slightly subjective in the choice and order of findings presented.

Discussion

What's the Discussion? Interpretation.

This section offers your interpretations and conclusions about your findings. How do your results relate to the goals of the study, as stated in your introduction, and how do they relate to the results that might have been expected from background information obtained in lectures, textbooks, or outside reading? This is your chance to demonstrate your ability to synthesize, analyze, evaluate, interpret, and reason effectively. You do NOT need to bring in theories to explain your ideas beyond what you have learned in class. Your readers are looking for well-supported opinions, not for leaps of fancy or mere repetitions of your findings, so you will need to think carefully about your findings in order to draw conclusions that are neither too narrow nor too broad.

- Interpret your results: evaluate, analyze, explain the significance and implications of your work--generalizations that you can draw from your results, principles that you support/disprove, conclusions about theoretical and/or practical implications.
- Explain key limitations: questions left unanswered, major experimental constraints, lack of correlation, negative results.
- Discuss agreement or contrast with previously published work; explain the significance of the corroboration or disjunction.

- Offer possible alternative hypotheses.
- Offer general conclusions, noting your reasoning and main supporting evidence.
- Recommend areas for future study and explain your choices.

See example

Notice:

- The authors link their findings to their interpretations.
- They explain WHY they think the results occurred.
- They hypothesize why certain results were unexpected.
- They do not repeat the visuals shown in the Results section (although some authors choose to add additional visuals to clarify their discussion)
- All figures which are included are labeled and referenced in the text prior to the figure.
- References to graphs and tables shown in the Results section are described by their figure number. If you choose, you may also refer to them by figure number and title.
- The authors have added subsections to organize the data.
- The Discussion is thoughtful and clearly written. You do not see overly ambitious interpretations or overly-technical language.

Works Cited - IEEE style

If you reference an outside source in your report, you should cite where you found that source. You should also cite sources which your reader, a fellow student, may be unfamiliar with. The appropriate style for citing sources in this report is IEEE style. Cite only material that you have actually read.

See example

For a complete reference guide to citing sources, see standards.ieee.org/guides/style/index.html

Appendix

Appendices include the original data taken during the laboratory session. Appendices should be numbered A, B, C, etc.

Other Writing Tips

- Keep it simple. The purpose of this report is to describe your PROCESS, not come to any conclusions that will alter the world.
- Jargon confuses your reader; it doesn't make you sound smart
- You may write from the first person point of view ("I" or "we") if that sentence style aids the reader in understanding your point better. BUT, remember you are not writing an autobiography, so try to use passive voice to keep the focus on our research rather than on you.
- "This." The antecedent "this" needs a noun. This what?

- "It." The pronoun "it" is not particularly descriptive. Use specific nouns as much as possible.
- Words like "very" and "really" do not add significance. Simply say, for example, "This findings was significant because . . ."
- You do not need to use phrases like "as stated above." In written communication, readers generally don't need such pointers as they remember what they've read previously in short reports. However, do reference figures and graphs: "As shown in Figure 3 . . ."
- Use non-sexist language. To avoid "he or she" constructions, write in plural form ("they").

Format

- A Table of Contents is not required, but will help your readers find information more quickly.
- Standard margins.
- Use a conservative font.
- Number the pages.

Specific Tips for Report 1

- No more than 10 pages
- No more than 10 graphs. You can write a fine report with only 5 graphs.

Important Dates

- First Draft Due: Friday, October 13
- Mya's Office Hours for report writing help: Wednesday, October 11 from 11am-3pm.
Location: TBD
- Writing Clinic: Tuesday, October 17 at 7:30pm
- Final Report Due: Friday, October 20